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U. S. DEPARTMENT OF AGRICULTURE

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CELERY GROWING



COMMERCIAL CELERY GROWING is an important industry, with about 15,000 acres devoted to the crop and the largest annual production about 7,000,000 crates. Celery is an important crop also in home gardens.

Methods of producing the commercial celery crop have materially changed within the past few years, new diseases have appeared, and a number of problems have arisen that call for information not included in earlier publications of the United States Department of Agriculture.

This bulletin discusses the fundamentals of successful celery production, including up-to-date methods of growing and handling the crop.

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CELERY GROWING.

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MANY PERSONS remember when celery was considered a novelty and used upon the tables of only a few people. Now, in sections adapted to its culture, celery is one of the most universal of our truck and home-garden crops, and the market demand has so increased that the production reaches thousands of carloads. According to crop statistics contained in the Yearbook of the United States Department of Agriculture for 1920, the acreage and production for the four years from 1917 to 1920 are as shown in Table 1.

TABLE 1.—*Acreage and production of celery for the four years from 1917 to 1920, inclusive.*

Year.	Acreage.	Production (crates).	Year.	Acreage.	Production (crates).
1917.....	14, 500	6, 597, 750	1919.....	13, 107	2, 676, 096
1918.....	14, 750	6, 436, 500	1920.....	15, 170	3, 660, 773

For many years celery was associated with turkey and cranberry sauce, and there was little demand for it except during the fall and winter months. In recent years, however, the season for celery has been extended to include practically the entire year. This has given rise to the phase of the industry known as "early" celery growing.

Commercial celery growing in the United States finds its greatest development in the general region of the Great Lakes, in Florida,

and in California. In the Great Lakes region, including parts of New York, Pennsylvania, Ohio, Illinois, Michigan, and Wisconsin, and also in New Jersey and Massachusetts, there are thousands of acres of muck soil especially adapted to celery production. In Florida the crop is largely grown on "hammock" lands and the drained lake-shore areas of the counties of Orange, Manatee, and Hillsborough. These soils are similar in many respects to the muck lands of the Great Lakes region, only they are not so old in their formation. In California the crop is grown mainly around Antioch, El Monte, Los Angeles, Holt, Walnut Grove, and Watsonville. The period of production for these various localities includes the greater part of the year. The early celery of the northern New Jersey and southern New York section supplies the markets during June, July, and August, followed by the later crop from the same general region, which continues on the market until January or February, this being followed by the California crop during the winter months and finally the Florida crop during early spring months. This makes it possible to have the market well supplied at practically all seasons.

Celery can be grown for home use throughout the greater part of the United States. There are sections, however, throughout the middle South where it is very difficult to get the plants started during the heated term of summer. Even here it is possible, however, by growing the plants under shade to produce enough celery for home use.

Celery requires two years to mature seed, but as ordinarily grown it is treated as an annual. The parts of the celery plant of the greatest value are the blanched leaf stems, which are usually eaten raw. Celery seed is extensively used for flavoring soups and a variety of dishes. The fleshy root of celery is often used in soups or is cut in small pieces, cooked until tender, and served with white sauce or drawn butter. The roots of a turnip-rooted form known as celeriac are more suitable for cooking than those of the common celery.

SOILS ADAPTED TO CELERY GROWING.

Celery grows naturally on low, moist, but well-drained soils, especially on the muck lands of the northeastern United States. It can be grown on almost any type of soil provided enough plant food is present and water is supplied during the dry periods, but most of the successful celery-growing enterprises are located on the low-lying muck or the "hammock" soils. There are a number of different types of muck soil, but those that are underlain with marl or some form of material bearing calcium carbonate are considered best. The depth of these muck beds varies greatly, being anywhere from 18 inches to 10 or 12 feet. The adaptability of the muck to the growing

of celery depends largely upon its texture and ability to supply the plants with plenty of moisture. These soils are usually high in nitrogen and deficient in both potash and phosphoric acid. If the proper physical conditions are found in the soil, the needed elements can be supplied in the form of commercial fertilizers or manure.

Celery is also grown quite extensively on level sandy loam soils, especially in the vicinity of Rochester, N. Y., in northeastern New Jersey, on Long Island, and in many other localities. While the crop is a little more difficult to produce on this type of soil, with modern methods of irrigating a very high quality of celery can be grown upon the sandy loam. Celery is grown to a limited extent on clay-loam soils, especially where these have been well provided with organic matter and where irrigation is available.

FERTILIZERS FOR CELERY.

With the increasing scarcity of manure it would not be practicable to depend upon this as a source of plant food for growing large areas of celery. The most successful growers in the northeastern section apply from 1,400 to 1,800 pounds of high-grade commercial fertilizer to the acre. This is sown broadcast with a fertilizer distributor after the land is plowed and is then worked into the soil by disking two or three times. As a rule this fertilizer contains about 4 per cent of nitrogen, 8 per cent of phosphoric acid, and 6 or 7 per cent of potash. During recent years there has been more or less of a scarcity of potash and the proportion of this element usually has been reduced to 4 or 5 per cent. This is followed by one or two side dressings of nitrate of soda or sulphate of ammonia during the growing period in the field. Where manure is available it is either applied in the fall and plowed under, then returned to the surface in the spring by replowing, or is composted in a pile and spread over the land after plowing and then disked into the soil the same as the fertilizer.

Celery growers of Florida frequently apply as much as 4,000 pounds of fertilizer to the acre—1,600 pounds when fitting the land and the remainder in the form of two or three side dressings during the growing period.

PREPARATION OF THE SOIL.

Where the land is fall plowed it should be broken rough and allowed to lie exposed to the weather during the winter. Where the land is plowed just previous to fitting for celery planting it should be disked and smoothed immediately after plowing. This will aid in settling the soil and reestablishing the moisture contact between the plowed portion and that beneath it. Most muck soils are easily

reduced to a good cultural condition and require only plowing and about two diskings and two draggings to get them in shape. On newly reclaimed muck soils, however, it is necessary to disk and drag several times before the soil is properly pulverized.

In Florida, where the celery crop is planted during the late summer and the early autumn, the land on which it is grown is generally covered with grass and weeds during the summer. Three or four weeks before the time for setting the celery the grass and trash are removed and the soil plowed and disked until in a finely pulverized condition. Just before planting, the soil is slightly ridged, by throwing two furrows toward each other, where each row is to be located, and then dragged down nearly level, the first installment of the fertilizer having been sown between the furrows and covered by the dragging.

GROWING CELERY PLANTS.

Good celery seed is often extremely difficult to procure, and as a rule the higher priced seed is the cheaper in the end. Most celery seed is imported, but there are a few growers in the United States who are making a specialty of producing high-grade celery seed of selected strains. Occasionally an individual celery grower produces his own seed, but the great bulk of the crop is grown from imported seed. About the only safeguard that the celery grower of to-day has in the matter of obtaining good seed is the reliability of the seedsman.

Strictly fresh seed is considered essential by most growers, but recent experiments conducted by the Massachusetts Agricultural College and Experiment Station have indicated that 4-year-old seed gives greater freedom from disease and in many respects is preferable to strictly fresh seed. Much depends, however, upon the way the seed has been kept, for in order to retain its vitality it should be stored where it will not be subjected to great changes of temperature. After the fourth year celery seed as a rule loses its vitality rather rapidly, and under no circumstances should old seed be used without first being subjected to a careful germination test. In experiments conducted by the United States Department of Agriculture celery seed germinated after being buried in the earth inclosed in a jar for 16 years. However, this would have little bearing upon the quality of seed kept in the ordinary manner. Without further experimental data it is recommended that seed not more than 4 years old be used and that even with these a germination test be made.

There are approximately 14,000 celery seeds in an ounce, but not every seed can be relied upon to reproduce a good plant. From 21,000 to 60,000 plants are required to set an acre, according to planting methods and distances. Enough plants with which to set

an acre will be produced by 6 ounces of extra good seed, but most growers prefer to sow from 8 to 12 ounces, so as to have an abundance of plants.

Owing to their small size, it is extremely difficult to sow celery seeds evenly. Good results may be obtained by mixing them with several times their bulk of finely sifted white sand, white corn meal, fine hominy grits, or any similar material that will not injure the seeds but will make their distribution less difficult. The writer has been very successful in starting celery seed by mixing about two days before sowing each ounce of seed with a quart of finely sifted moist muck soil. The mixture is slightly packed down in a small box or a stoneware jar and should contain just sufficient moisture to swell the seeds. At the end of two days the soil containing the seeds is spread evenly over the surface of the tray or bed where the plants are to be grown, at least 20 square feet of bed space being provided for each ounce of seed. After the seeds are distributed the surface of the bed is firmed a little by means of a light board and covered with a single thickness of burlap made by ripping feed or fertilizer bags. If the temperature is favorable the seeds will begin to sprout in about five days; meantime the burlap covering must be moistened frequently. When the young seedlings begin to appear, the burlap covering is removed and the bed shaded with a lath shade, the openings of which are the same width as the lath.

Some of the most successful celery growers of the Kalamazoo (Mich.) section mix their celery seed with moist muck soil, as described above, and then place the boxes or pans containing the mixture in a temperature of about 70° F., usually in a hotbed, for about 10 days or until the seeds begin to sprout. The mixture is then spread evenly over the surface of the trays or the plant bed and a thin layer of muck soil sifted over it. By this method a uniform stand of plants can always be secured, since the germination of the seed will be very apparent at the time the mixture is spread upon the plant bed.

Good, stocky, well-developed plants are the first essential in the production of a profitable celery crop, and special attention must be given to the growing of the plants. The methods followed will necessarily depend upon the time of the year at which they are grown. For the early celery crop the seed is sown in hotbeds or greenhouses 8 to 10 weeks before the time to set the plants in the field.

Plants for setting the late or main crop of celery are grown in coldframes or in specially prepared field beds. Before sowing the seed the surface of the beds is raked smooth, and after the seed is scattered it is again raked very lightly and slightly firmed by means of a board or light roller. Water is supplied to the surface either

by means of sprinkling cans or from an overhead irrigation system. After the plants appear, watering must be done very carefully to avoid damping-off. The field plant beds are usually made about $3\frac{1}{2}$ or 4 feet in width with paths between them to facilitate hand weeding and watering.

TRANSPLANTING.

For the extremely early celery crop the plants as a rule are transplanted to trays (fig. 1), to greenhouse benches, or to coldframes three to five weeks after the seed is sown. Transplanting accomplishes two purposes: (1) The seedling celery plant has a straight root, or taproot, which is broken in transplanting, causing a large mass of fibrous roots to be formed. In the case of a plant allowed to remain in the seed bed until planting time, this

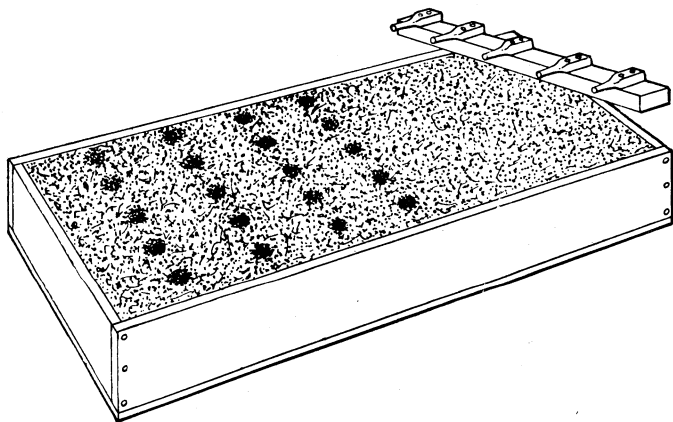


FIG. 1.—A flat, or tray, used for transplanting celery, with a marker for making holes in the soil, into which the seedlings are set.

taproot has gone far down into the soil, the plant has formed very few side roots, and consequently it suffers in the process of transplanting in the field; (2) when transplanting twice—that is from the seed bed to specially fitted beds, trays, or coldframes, then later to the fields—is practiced there is no necessity for thinning the plants in the plant bed, and a more uniform lot of plants is obtained. Figure 2 shows the effect of transplanting, the two plants being from the same seeding. Two handlings can not be recommended for the main, or late, crop when grown on a large scale, because the cost of labor is too great.

Much time can be saved in transplanting if the soil in the beds, trays, or coldframes into which the plants are set is sifted and in the best possible condition. Some growers are following the practice of sterilizing the plant-bed soil with steam, in order to guard

against damping-off and also to kill the weed seeds that are usually so plentiful in this type of soil. Transplanting will also be expedited by using a marker, such as shown in figure 1, consisting of a lath to which are fastened a number of little round pegs $2\frac{1}{2}$ or 3 inches apart. These pegs are pressed into the soil to a depth of about $1\frac{1}{2}$ inches, forming holes in which to set the plants.

Another method sometimes followed in growing early celery plants is to sow the seed rather thinly in the greenhouse benches, then when the plants are about $1\frac{1}{2}$ inches in height a knife or cutter is run beneath them, cutting off the taproot, and slightly lifting the plants in the soil. They are then watered to settle the soil firmly about them, and a new root system soon develops. The cutter should be drawn at least $1\frac{1}{2}$ inches below the surface. This method of lifting or cutting under is practiced in the field beds the same as in the greenhouse benches except that in the field a cutting bar mounted on wheels and provided with handles, as shown in figure 3, is generally used. The cutting of the taproots is done six or eight days before the plants are to be set in the field.

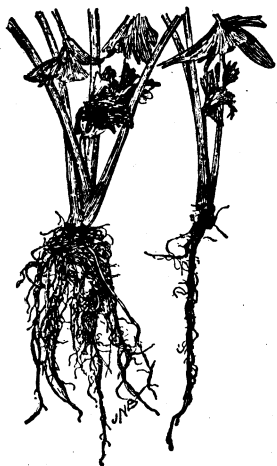


FIG. 2.—Celery plants, showing the effect of transplanting on the root system, due partially to the fact that each transplanted seedling is given sufficient space for its proper development.

Two or even three pullings of plants are made from each outdoor bed, the larger plants being taken first, allowing the smaller ones to develop for later planting. Most celery growers follow the practice of sowing seed at periods of about two weeks, in order that the plants may not all be ready for setting at one time; then by drawing from each bed two or three times, a continuous supply of plants is maintained. Where celery is grown for storage purposes it is the aim to plant and mature the entire crop within a reasonably short time, or just as fast as it can be handled.

GROWING PLANTS FOR THE HOME GARDEN.

Two or three hundred celery plants for planting in the home garden can be started by sowing the seed in a cigar box or in a small wooden tray in the house and transplanting to other trays. As a rule, it is more economical to purchase the small number of plants needed for the home garden from some plant grower, but when grown at home they can be lifted with a ball of earth adhering to their roots and thus make a better start than those ordinarily offered for sale. Special care is needed during the first two weeks after the seed is

sown to see that the soil does not dry out and after the plants come up that they are not overwatered.

SETTING CELERY.

Where plenty of land is available, celery that is being grown for home use may best be planted in single or double rows 4 or 5 feet apart, with the plants 6 inches apart in the row. If the space is limited the plants may be set in solid beds 8 or 10 inches apart in each



FIG. 3.—Device for cutting under celery plants in the plant bed.

direction. By planting in rows the crop may be worked with a horse cultivator or wheel hoe at less expenditure of energy than where grown in a solid bed. Celery for the market is practically all grown in rows consisting of either a single line of plants or of double lines 6 inches apart. Early celery, especially that grown in coldframes, is set by the solid-bed method, as shown in figure 4, and while the plants are placed in distinct rows, the rows are close together and require hand cultivation. The number of plants required

to set an acre depends upon the planting method used. Table 2 covers the methods in most common use.

TABLE 2.—*Planting distances, number of plants, and blanching requirements of the celery crop.*

Distance between rows.	Distance between plants.	Method of blanching.	Requirement per acre.	
			Lumber.	Number of plants.
	<i>Inches.</i>		<i>Sq. ft.</i>	
3 feet, single.....	6	Boards 1 by 10 inches.	25,000	29,040
4 feet, double.....	6	do.	18,500	43,560
4 feet, single.....	6	Earth.....		21,780
5 feet, double.....	6	do.		35,000

METHODS OF PLANTING.

Celery plants are now set entirely by hand, but there is no reason why a suitable machine should not be developed for doing the work.



FIG. 4.—Growing early celery in coldframes.

First, the land is marked off in rows, usually by means of a marker similar to that used in marking for corn, but sometimes a line is used. Where the fertilizer is sown broadcast and harrowed into the soil the surface will be in a comparatively loose condition, and it is generally necessary, especially on muck soils, to go over the surface with a light drag or roller just before planting. For effective work the crew doing the planting should consist of two people pulling plants from the bed and as many boys dropping plants as there are plant setters. In Florida it is customary to organize a gang of

about 10 or preferably 11—2 at the plant bed, 4 boys dropping plants, 4 plant setters, and 1 extra man to keep the droppers supplied with plants. Where the plants are irrigated immediately after setting, this work also may be handled by the extra man. In certain of the celery-growing sections of the Great Lakes region the plants are placed in shallow pans or trays by the persons pulling them from the bed and are set direct from these pans or trays by the plant setters. While the plant setters can not handle quite so many plants in this manner as where they are dropped ahead, the plants do not dry out and can be planted in better condition. In setting the plants the men doing the work wear knee pads and work upon their knees as shown in figure 5, either at one side or astride the row, moving themselves along by a sort of rocking motion as the plants are being set.



FIG. 5.—Setting celery plants.

A well-organized gang of 9 to 11 people will set from 1 to 1½ acres a day, or about 10,000 plants for each setter.

Plant setting is frequently very seriously interfered with by dry weather, and it is necessary either to use irrigation or wait for a "season" in order to have the plants live. Pinching or cutting off the top leaves in order to lessen the drain upon the plant is sometimes practiced, but most growers believe that this practice is injurious. Unless the foliage is extremely heavy, the plants should be set with all their leaves upon them and then watered sufficiently to sustain them. It is extremely important, however, in setting that the soil be well firmed around the roots of the plants and that the surface soil which becomes compacted between the rows during plant

setting be loosened with a small-tooth cultivator as soon as possible after the plants are set. Mulching around the plants with lawn clippings, very fine straw, or, better, with decayed manure, is recommended in growing a small supply of celery in the home garden. After setting the plants the surface soil should be well watered just before the mulch is applied. By mulching, the moisture is retained, the surface soil is protected from the sun, and a certain quantity of plant food is added to the soil. This is especially true where a good grade of manure is used as a mulching material. Mulching is sometimes practiced where early celery is being grown in cold-frames, but it would scarcely be practicable on a large scale in the open field.

IRRIGATION OF CELERY.

Celery is a moisture-loving plant, and unless the soil on which it is grown is of a naturally moist character watering will be necessary. Three systems of applying water to the celery crop are in general use: (1) The overhead-sprinkler system, (2) the furrow or surface system, and (3) the underground or subirrigation system.

IRRIGATION BY OVERHEAD SPRINKLERS.

Throughout the celery-growing districts many fields are equipped with the overhead-sprinkler system, consisting of lines of pipe supported on posts, these pipes being fitted at intervals of 3 feet with small nozzles which distribute water over a space of 50 or 60 feet in each direction from the line of pipe. The only objection to a system of this character is the first cost, the expense of operation after installation being moderate. In view of the fact that celery is an intensive crop that must be supplied with water, this system is about the only one that will meet the requirements under most conditions where celery is grown for the market. The essential in the operation of any irrigation system is a plentiful supply of water, and in the case of the overhead-sprinkler system the water must be free from sediment or other material that will clog the small nozzles. The cost of equipping an acre will depend (1) upon the number of acres, (2) upon the distance from the source of supply to the field, and (3) upon the market prices of the materials. Under the usual range of conditions this cost will be \$400 to \$500 an acre.

SURFACE OR FURROW IRRIGATION.

By far the cheapest method of irrigating celery is to allow the water to flow in shallow furrows alongside the rows. This is practicable only where the lay of the land, character of the soil, and other conditions are suitable. This method will not work on muck soils,

because of their porous character which allows the water to sink away rapidly. It serves well, however, on sandy loam soils, especially those having a clay subsoil and where the ground slopes just enough to provide for the flow of the water. In a few districts where celery is grown on extremely level land moderate flooding can be resorted to.

SUBIRRIGATION OR UNDERGROUND WATERING.

Many of the celery fields of Florida are fitted for irrigation by lines of tile laid underground, these serving also to drain the land during the wet season. In this district artesian wells supply 300 to



FIG. 6.—Pumping outfit used for the drainage and irrigation of celery land.

400 gallons of water per minute. This flow of water is conducted through an open trough sunk into the ground and distributed to the tiles as desired, the water escaping through the joints of the tiles and saturating the soil. In case too much water is applied or the ground becomes oversaturated by rainfall, the plugs are removed from the drainage end of the tiles and the surplus water allowed to run off.

A modification of this subirrigation system is found in certain of the muck beds of the Great Lakes region. There the land is drained by means of open ditches connecting with a main discharge ditch at the end of the field. The sources of supply of water are usually springs which underlie the muck bed, and by cutting off the outflow at the lower end of the field the water is backed up into the soil until it becomes saturated. The ditches then are opened again and the surplus water allowed to drain off. One enterprising grower in

Bergen County, N. J., has installed the pumping outfit shown in figure 6, having a capacity of several hundred gallons per minute, with which he can drain the water from the ditches of his celery field. This pump is so arranged that its action can be reversed and during dry weather water may be pumped through the ditches back into the field, thus raising the water level in the soil until moisture is brought to the surface through capillary action.

PRINCIPLES OF IRRIGATION PRACTICE.

Selection of a suitable irrigation system for celery growing will depend upon local conditions, but in most cases the overhead-sprinkler system is most adaptable. Much depends upon the intelligent use of the irrigation system and the exercise of good judgment as to when to apply the water.

Successful growers have found that celery is greatly injured by wilting, and therefore they watch the soil and moisture conditions carefully and apply water before any wilting of the leaves occurs. Where flooding or the subirrigation system is practiced, care must be taken that the soil does not become water-logged and that proper drainage follows each irrigation.

GROWING CELERY WITHOUT IRRIGATION.

Some very successful celery growers of the Boston district, located on upland, do not irrigate their crops during the entire growing period. They depend (1) upon having the soil in good condition and well supplied with organic matter which will hold the moisture and (2) upon giving frequent shallow cultivation, to prevent evaporation and to keep the moisture near the surface. A large percentage of the commercial celery crop grown on the muck lands of the northeastern United

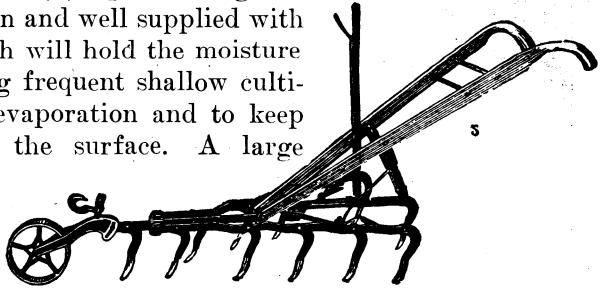


FIG. 7.—Small-tooth horse cultivator.

States is handled without irrigation, natural rainfall and soil moisture being depended upon, except possibly one or two light waterings at the time the plants are set.

CULTIVATION.

While the greater part of the work of cultivating the celery crop may be performed by means of horse-drawn or motor-propelled tools, some hand weeding and hand hoeing will be necessary. Handwork, however, can be reduced to a minimum by the frequent shallow stir-

ring of the soil, thus keeping the weeds from getting a firm hold. Where a mulch has been placed around the plants the cultivation should be brought only to the edge of this mulch, as it will not be necessary to stir the soil nearer the plants. Under ordinary circumstances, where no mulch is used the small-tooth cultivator should be run close to the plants, but very shallow. A cultivator of the type shown in figure 7 is very commonly used for this work, although some growers are now using to advantage riding cultivators which straddle the row. In some cases motor cultivators are used. For the home garden the wheel hoe or hand cultivator shown in figure 8 answers every purpose.

When a crop of celery is in good growing condition, the roots will be near the surface, and during a dry season a shallow dust mulch

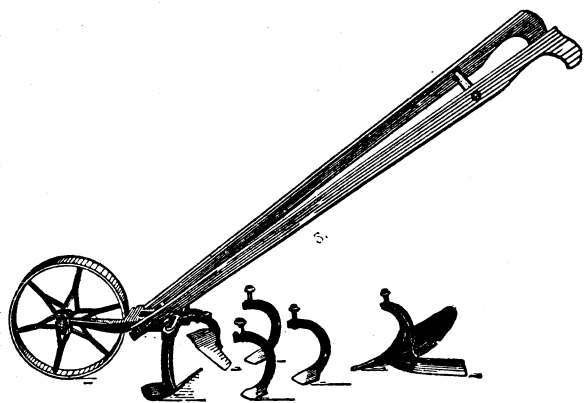


FIG. 8.—Wheel hoe suitable for working close to the rows of small celery plants.

will help to retain the moisture. At least one cultivation should follow as soon as possible after irrigation, and it is best to give a second cultivation just before applying the next irrigation. The roots of celery, like those of corn, spread quite a distance, seeking moisture, plant food, and air,

and if the entire surface of the soil is kept in a loose, porous condition to a depth of about 2 inches, growth will be greatly promoted. Deep cultivation will have the tendency to break too many of the roots and cause a check in the growth of the plants. Late in the afternoon or in the early evening is the best time for cultivating celery.

DISEASES.

Growing celery is subject to attack by a number of diseases, among the most important of which are the damping-off of the plants in the seed bed, early and late blight, bacterial blight, Sclerotinia rot, and black-heart. The several blights, though caused by different organisms and characterized by differences in the type of leaf spots and other characters, resemble each other to a considerable extent and, since the methods of control are the same, will be discussed together. While celery is in storage and in transit heavy losses are

¹ Prepared by I. C. Jagger and W. W. Gilbert, of the Office of Cotton, Truck, and Forage Crop Disease Investigations, Bureau of Plant Industry.

sometimes experienced from a number of troubles grouped under the general name of storage rots.

Celery plants are very frequently destroyed in the seed bed by a disease known as damping-off. While this disease is caused by a fungus, it is usually induced by careless watering and where plants are grown in hotbeds, greenhouses, or coldframes with sash or cloth covering by lack of ventilation, either of which furnishes conditions favorable to damping-off. Care to avoid overwatering and to give an abundance of fresh air without too great a draft directly upon the plants will do much to prevent losses from damping-off.

Infection by the several blights usually takes place two or three weeks before the disease makes its appearance in the form of grayish or water-soaked spots upon the leaves. These change to a brown or burned appearance in a few days, spreading to all parts of the plants, but being most apparent on the outer leaves, the new growth of the plant not being affected for several days. The spores or germs which cause these blights are readily carried in various ways to all parts of the field or to adjoining fields, and the only safeguard is a thorough coating of the celery foliage with a spray mixture that will prevent their development.

Celery blights spread rapidly during periods of moist, sultry weather. Bright sunshine and a clear atmosphere retard their development. Plants that are growing vigorously will sometimes in a measure keep ahead of the disease, but thorough spraying is essential for control.

Black-heart, which causes heavy losses in the Florida celery districts, is probably not a transmissible parasitic disease, but a physiological trouble caused mainly by high temperatures. This trouble, however, opens the way for the entrance of other diseases, such as the soft rots.

The storage rots, although closely dependent on temperature and moisture conditions in the storage house or car used for shipment, in most instances have their origin in field diseases. Plants severely affected with early-blight dry out and shrivel in storage, and their market value is greatly reduced. Late-blight causes a soft-rot in storage which often results in serious losses. Sclerotinia rot frequently develops watery soft-rot in storage, and black-heart often leads to heart-rot. The best methods of controlling storage rots require crop rotation and spraying with Bordeaux mixture to prevent field diseases, the rejection of all but healthy stock for storage, and the maintenance of proper storage conditions, including adequate ventilation and low temperature. For long-distance shipment precooling has shown many advantages over shipment by refrigerator cars without precooling.²

² For a full discussion, see Ramsey, H. J., and Markell, E. L., The handling and precooling of Florida lettuce and celery, U. S. Dept. Agr. Bul. 601, 29 p., 19 fig. 1917.

CONTROL OF CELERY DISEASES.

Recent demonstrations conducted by the New York State College of Agriculture in the Williamson (N. Y.) section have shown that five applications of Bordeaux mixture of the 5-5-50 strength have given excellent control of celery blight. The results of these tests were read in terms of the number of blight spots appearing per plant on the sprayed and unsprayed portions. On six farms the average number of spots per plant on the sprayed area was 63, while on the same farms unsprayed plants carried an average of 1,079 spots per plant. In other words, the spraying proved 94 per cent effective. According to the New York State College, spraying in the plant bed is desirable in sections where blight infestation is especially bad, and after setting in the field the plants should be sprayed once a week until at least five sprayings are given, the spray being applied at high pressure, so that every part of the foliage will be thoroughly coated with a fine spray. These results are in accordance with those obtained by the best celery growers of the northeastern section, who have found that spraying with the 5-5-50 Bordeaux mixture is effective in the control of blights. In Florida, however, it has been found that from 10 to 15 sprayings are often necessary during the growing season in order to hold blight under control. Very thorough spraying is also required in the California celery regions.

In making up the 5-5-50 Bordeaux mixture, 5 pounds of copper sulphate is dissolved in 25 gallons of water; 5 pounds of fresh stone lime is slaked in a small quantity of water, then strained, and diluted to 25 gallons, and the two solutions of 25 gallons each are then poured together, thoroughly stirred, and used immediately. In order to get the bluestone or copper sulphate in solution it should be placed in a burlap bag and hung in the 25 gallons of water near the top several hours in advance of making up the Bordeaux mixture. If for any reason it is not convenient to dissolve it in this manner, it may be dissolved in 2 or 3 gallons of hot water and then diluted to 25 gallons. The copper-sulphate solution should always be handled in stoneware jars or wooden tubs or barrels, as it attacks metal containers.

Stock solutions of both the copper sulphate and the lime may be made by dissolving the copper sulphate and the lime separately at the rate of 1 pound to 1 gallon of water. If not convenient to dilute both solutions, either the lime solution or the copper-sulphate solution can be placed in the spray tank, the tank filled nearly full of water, then the remaining concentrated solution added, keeping the agitator running or stirring the mixture vigorously. In using stock solutions these should be kept covered to prevent evaporation and should be thoroughly stirred before taking any out for use. **In no**

case should the concentrated stock solutions of copper sulphate and lime be mixed, but should be brought together only after one or both have been diluted.

Spraying should be done when the weather is reasonably calm, and the best results can be obtained only by applying the spray under high pressure through nozzles that will produce a fine mist, so that every part of the plant is coated. There should be three nozzles to each row, one directly over and one on either side of the row and so arranged that the under side of the leaves will be coated with the spray. A potato sprayer or any good horse-drawn or power sprayer of a type that will straddle one or two rows of celery will answer. Across the back of the sprayer a boom or crosshead pipe is so arranged that it will spray three to five rows at one time.

Dusting of celery to control disease is still more or less in the experimental stage, and successful celery growers to a large extent practice spraying. A dry mixture consisting of 15 per cent anhydrous copper sulphate and 85 per cent of hydrated lime known as Sanders dust, named after the Canadian entomologist who devised the mixture, has given promising results in an experimental way. One difficulty lies in the application of the dust, due to the fact that no satisfactory special dusting machines have as yet been devised for performing this work.

That certain varieties and strains of celery are more susceptible to the attack of diseases than others can not be questioned, but the diseases are present in every locality where celery is grown commercially, and the problem of controlling these diseases should be taken into consideration as a part of crop production. Spraying has thus far proved the most effective control, and the economy of doing the work depends largely upon the use of suitable equipment. High pressure and uniform distribution of the spray over the entire leaf and stem surface of the plants are essential, the number of applications depending upon local conditions.

Crop rotation in celery growing is recommended the same as for other truck and field crops. Cases are on record where celery has been grown consecutively on the same land for seven years without harmful results, but this is contrary to the accepted theory of a proper cropping system. Authorities differ in their views as to the value of crop rotation in its relation to disease control, but it stands to reason that such diseases as celery blights would be cumulative in their effect, especially where great quantities of disease-laden trimmings are allowed to remain on the soil or are plowed under. Disregarding the disease-control feature entirely, proper rotation of crops is desirable in order to maintain the fertility and the proper physical condition of the soil.

BLANCHING.

Banking with earth was originally the only method employed for blanching celery, and this practice is still very largely followed in certain of the important celery-producing sections. In order to obtain sufficient earth for banking the celery to the top it is necessary to have the rows at least $3\frac{1}{2}$ or 4 feet apart. Banking with earth produces a celery of superior quality and protects the crop from early frosts.

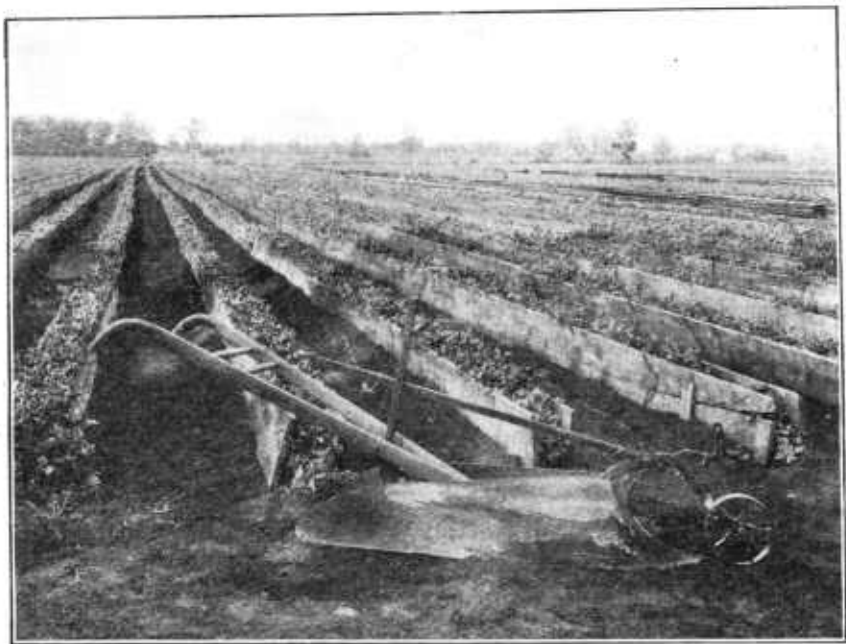


FIG. 9.—Field of celery in the process of blanching by means of boards, with a celery hiller in the foreground.

In fields growing commercial celery the earth is worked toward the rows of celery by means of a banker, or celery hiller, such as is shown in the foreground of figure 9. To complete the work of drawing the earth around the plants, broad-bladed hoes are used. Celery can often be left in the field two or three weeks after the first frosts, provided the earth is drawn well up to the tops of the plants. Sometimes where the rows are closer than $3\frac{1}{2}$ feet every other row of celery is blanched with boards and is dug early and marketed, the remaining rows being banked with the surplus earth and allowed to remain until later.

Boards and strips of specially prepared paper are extensively used for blanching the commercial celery crop. Early celery, which is marketed during June and July, is for the most part blanched by means of boards or paper. With the rows of celery 30 inches apart,

approximately 30,000 board feet of seven-eighths by 10 inch lumber will be required to blanch an acre. At present prices this means an investment of \$1,200 to \$1,400. Pine and cypress lumber is most commonly used, and it has been found desirable to have the boards dressed on both sides and the edges smoothed so they will not splinter in handling. New lumber has the objection that it sometimes imparts an undesirable flavor to the celery. The boards are hauled to the field in high-wheeled wagons which straddle the rows, and they are first placed along the rows, as shown in figure 10, being held



FIG. 10.—Boards placed along rows of celery during the first stages of blanching. After a few days the tops of the boards are drawn closer together to exclude the light.

in position by stakes with the tops of the boards sloping slightly outward. After 8 or 10 days, when the celery has grown so that the center leaves are even with the tops of the boards, the boards are drawn together more closely and fastened in place by means of wire spanners, as is done in blanching the fall crop. As a rule celery can be blanched in from 15 to 24 days, and the boards may be used several times during a season. At the end of the season the boards should be piled with strips between them, the top layer of the pile being made to serve as a roof to protect the lumber until wanted for use the following year. Treated in this manner a good grade of lumber will last 12 to 15 years.

Heavy paper in strips 10 and 12 inches wide and 100 feet in length has been used to a considerable extent for blanching celery, especially in the Florida section. Paper has the advantage that it is

lighter to handle than the boards and can be put on much more quickly. On the other hand, boards will outlast the paper two or three times. The paper most commonly used consists of a black insulating material put up in rolls about 300 feet in length and weighing 90 pounds to 1,000 square feet. This paper when properly made is thoroughly waterproofed with a material that does not injure the celery. The paper is unrolled along the rows and held in place either by means of stakes or more often with special wire brackets.

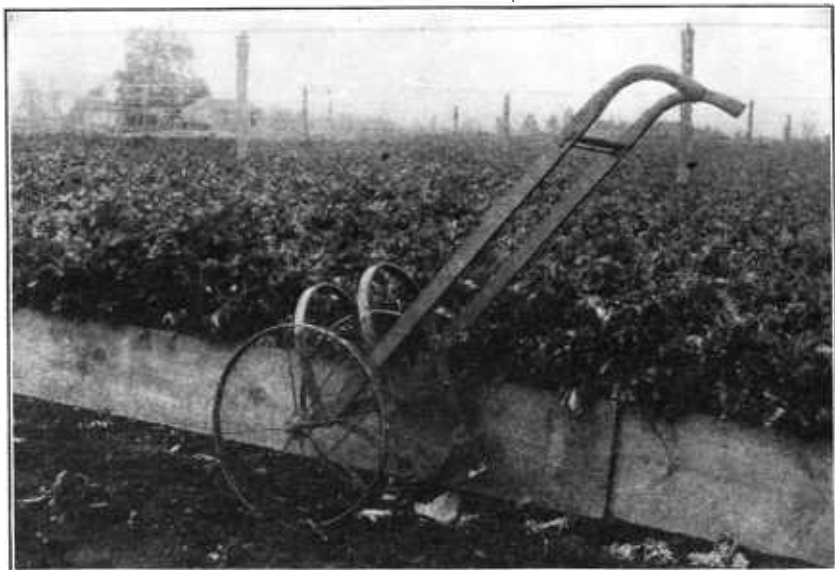


FIG. 11.—Hand celery digger.

Paper bands which may be fastened around each individual plant by means of a short string are not practicable on a large scale, but this method is adapted to use in the home garden. Any good heavy paper will answer, provided it does not contain any tar or creosote to injure the flavor of the celery.

Ordinary farm draitiles of about 3 inches inside diameter and a foot in length make excellent blanchers for celery grown for home use or where it is grown on a very small scale for the market. In using the tiles for blanching, the bunches are first tied together with a short piece of string; then the tile is slipped down over the top of the bunch. Draitiles are especially desirable from the standpoint of producing celery of good flavor, but they are too cumbersome and expensive for use on a very large scale.

HARVESTING.

Early celery and that grown in such sections as Florida and California should always be marketed just as soon as the crop is suffi-

ciently blanched; otherwise serious losses from decay are liable to occur. The first step in harvesting celery that is blanched in boards is to remove the spanners and allow the boards to fall in spaces between the rows of celery. When paper is used, it must be rolled up and removed. The celery is then loosened from the ground, either by means of a hand cutter similar to that used for cutting under the plants in the plant bed (fig. 11) or more often with a sharp spade, the object being to sever the roots about an inch below the base of the leaves. Where the celery is banked with earth it is loosened from the soil by means of a horse-drawn cutter mounted on wheels and provided with levers for regulating the depth of



FIG. 12.—Stripping the outer leaves from celery after digging and before packing it in the crates.

the cutting blade, this being determined by the sound made by the cutting of the roots. Following the cutting the trimmers lift the celery, shake off the earth, and strip the plants of their outer or rougher leaves, as shown in figure 12. The plants are then placed in piles ready for packing in the crates. If too much of the root has been left by the cutter, this excess is trimmed off by means of large knives.

Two methods of packing are followed, one in the field, where the celery is packed without washing, and the other at the packing house, where the plants are trimmed, washed, and tied in bunches of 12 to 18 plants each, according to the size of the individual stalks, before being packed in crates. Celery that is to be shipped long distances in refrigerator cars and that which is held in storage houses under refrigeration is packed in the crates in the field, and later when placed upon the market it is given its final trimming and washed. In order to have the celery keep in good condition, either in the car or under refrigeration, it should be packed reasonably dry; that is, without

any surplus moisture adhering to the leaves or stems. Where the celery is to be stored in a pit or in a storage house without refrigeration and the roots set in soil, very little trimming is necessary and considerably more root is left upon the plants than in the case of immediate shipment or refrigeration. Figures 13 and 14 give a good idea of the methods followed in the rough packing of celery in the field. Figure 15 shows the wagons being loaded with crates of celery for hauling to the storage house or to the car. In case the distance to the loading point or storage house is great the crates are transferred to motor trucks at the entrance to the farm, as the celery fields are usually too soft for the trucks to go directly into them.



FIG. 13.—Packing celery in crates in the field.

The number of individual stalks or full-grown celery plants that may be packed in a crate will depend upon (1) the growth the celery has made, and (2) the size and style of crate. The number varies from 36 to 80. As a rule, however, 48 to 54 rough-trimmed plants make a crate. When the celery is fully trimmed, washed, and bunched, 6 to 10 dozen make a crate.

Harvesting celery on a large scale is usually done in an organized way with 1 man removing the boards, 2 cutting the celery loose from the soil, and 4 or 5 men or women doing the trimming. About 2 men will be required for packing in the crates, 1 for nailing on the tops, and an extra man to help the teamsters load the crates upon the wagons. This will make a gang of about 14 persons, in addition to the teamsters who haul the celery from the field, and this crew, under good conditions, will cut and pack 1,000 to 1,200 crates of celery a day.

SHIPPING.

Celery grown in the California district is shipped in crates 24 by 24 by 20 inches (fig. 16). Crates of this size are also used in

the Great Lakes region, but recently a smaller crate, 24 by 20 by 16 inches in size, has been largely adopted. The greater part of the Florida crop is shipped in a special flat crate 24 by 20 by 11 inches. The objection to the large cubical crate used by the California growers is that it is difficult to cool the celery to the center of the crate. In some cases strips have been nailed through the center of these crates to form ventilation space, but the crate shown in figure 14, 24 by 20 by 16 inches in size, seems to give better results both in storage and in shipment. Occasionally a car of celery is shipped on decks, two decks being placed above the floor of the car. This method is resorted to only when for some reason crates can



FIG. 14.—Packing celery in 24 by 20 by 16 inch crates.

not be obtained. In order to facilitate handling for deck shipment, the celery is roughly tied in bundles of about 12 plants each. In most cases where celery is shipped in earload lots it is given its final trimming and washing after reaching its destination.

STORAGE.

Storing celery from two to four months under refrigeration has recently become quite common, especially in the Great Lakes region, the methods of handling being practically the same as those where the celery goes direct into refrigerator cars. The storage chambers are built of hollow tile insulated with cork and cooled direct from an ammonia refrigeration plant. These chambers as a rule are about 32 feet in width, 60 to 80 feet in length, and about 14 feet in height, with a doorway at each end. One end opens on the wagon platform and the other on the railroad siding. The

crates of celery are stacked to the ceiling with 1 by 3 inch strips between the layers of crates to hold them steady and provide extra ventilation. A narrow space is left around the outer walls and in some cases a narrow passage is left through the center, but otherwise the celery crates are stacked practically in a solid mass. A temperature between 33° and 34° F. is maintained at a point about the height of a man's head, but this temperature varies to some extent in different parts of the chamber. Celery in storage freezes at a temperature of 29.86° (approximately 30° F.), and care must be taken that the temperature of the storage chambers does not go too low.

In a few chambers fans have been installed to stir up the air, especially when the celery is first stored and contains considerable latent heat. While much remains to be determined relative to the



FIG. 15.—A type of wagon frequently used to haul the crates of celery from the field to the storage house or car.

best conditions under which celery may be stored under refrigeration, the method described above has proved quite satisfactory, and large quantities are being kept under refrigeration each year.

Storage cellars and special celery houses without refrigeration are suitable for holding celery for a short period, or up until the holidays in the northern sections. This method of storing, however, can not be recommended for Florida or California conditions. These storage cellars as a rule are constructed partly underground, and consist of concrete or brick walls and a heavy double roof supplied with numerous ventilators. Doors are provided in each end of the house, and the celery is stored by packing the roots in a few inches of moist soil on the floor. Care must be taken in the management of a storage house of this character to prevent the loss of celery from decay. The main essentials are to keep the temperature of the house as low as possible through ventilation, especially during the night and when a cool wind happens to be blowing. Another im-

portant point is to apply water to the roots of the plants without wetting the tops. This can generally be accomplished by inserting the hose in the spaces between the rows of plants and flooding the soil with water. Thorough ventilation after watering is very necessary.

Holding celery in trenches either in the field or in a special inclosure is often practiced where a surplus is being held for a short period only. The trenches are cut with a spade or a plow 12 to 18 inches in width, the celery packed closely together in them with the roots embedded in the soil as shown in figure 17; then the remaining soil is banked up on the outside, and as cold weather comes

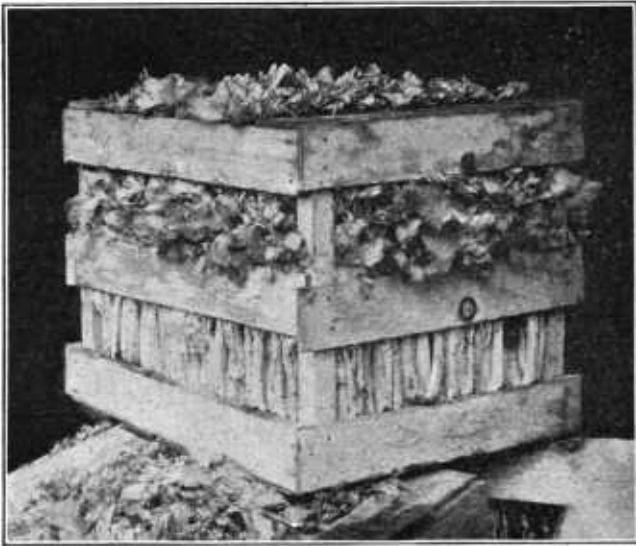


FIG. 16.—Crate of celery packed in the field and shipped without washing.

on the top is covered with boards, or often with straw. In some cases no covering whatever is placed over the tops of the plants, the foliage of the celery being depended upon to protect the stems from frosts and light freezes. Celery stored in this manner, however, should be marketed before severely cold weather.

A supply of celery for home use can often be stored to advantage in the pit of an ordinary hotbed, as shown in figure 18, and covered over with boards, straw, and leaves to keep out the frost. Celery may be safely stored in cellars, provided the temperature is kept low and plenty of ventilation maintained. The ordinary house cellar, however, is entirely too warm for keeping celery any considerable length of time. For home use the outdoor pit or the unused hotbed or cold-frame is perhaps the best place for keeping a supply.

PREPARATION FOR MARKET.

Celery must be thoroughly washed and all the outer or rough leaves trimmed off at some point in its handling, preferably after it reaches its destination and just before being placed upon the market. Where the delivery is direct from the farm to the local market the washing and bunching can best be done on the farm, but in all the large markets some dealers are equipped for washing and bunching the celery just before it is offered for sale. The trimming is usually done by means of rather short-bladed butcher knives and the stalks are



FIG. 17.—Trenching celery for short-period storage or home use.

trimmed and bunched as shown in figure 19. This is the standard bunch, containing ordinarily a dozen individual stalks, but where the celery is small a larger number of stalks go to make up the standard bunch. In a few cases washing machines are employed for removing the dirt from the celery, but as a rule the trimmed celery is simply thrown into a deep tank of cold water and the dirt removed by using rather stiff brushes. From the washing tank the celery goes into another tank of clean cold water, from which it is rinsed and spread on trays to drip before bunching. Bunching forms or bunching devices of some kind, usually consisting of a square box mounted on a table and provided with a strap attached to a foot lever, are employed for forming and compressing the bunches. The bunches are tied

with one-fourth-inch pink tape, which comes in large spools, these spools being hung overhead so that the tape will be in easy reach of the person doing the bunching.

A number of the growers of the Great Lakes region have built up a special trade on celery bunched in threes and fours. This class of special home trade provides a ready market for the smaller celery, which consists mostly of heart. Great quantities of celery, the outer parts of which, due to long shipment or some other cause, do not have an attractive appearance, are trimmed closely and find sale in many

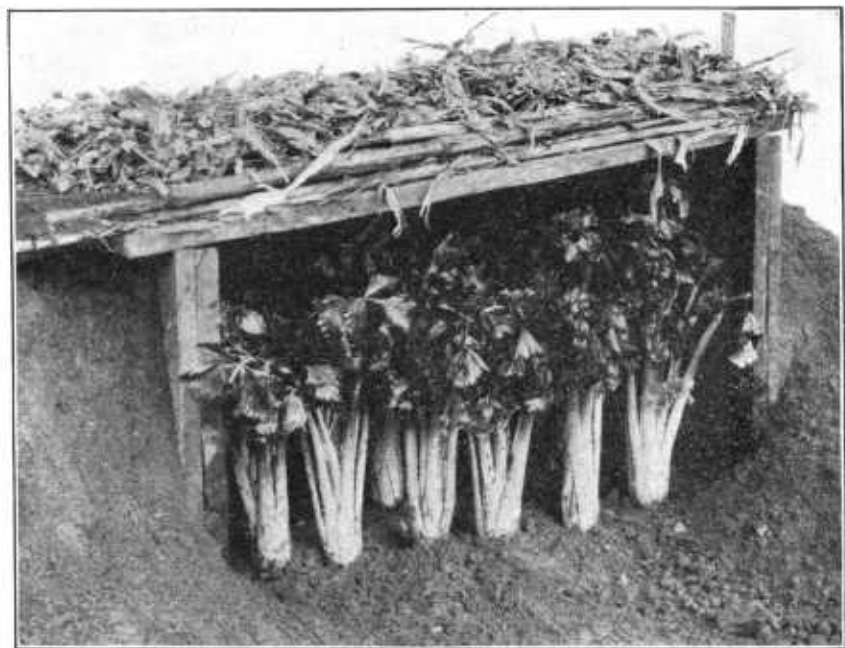


FIG. 18.—Cross section of a hotbed pit used for the storage of celery on a small scale.

of the large cities through the medium of street venders. The dealers provide special facilities for bunching celery in threes and fours to meet this trade, as it gives them an outlet for the celery that could not otherwise be sold to advantage on the regular market. This celery is often just as good as, or even better than, that which has a much finer appearance, because it consists mainly of hearts and there is very little waste in its use.

Frequent changing of the water in the wash tanks and general cleanliness of the washroom are important factors in the handling of celery during its final preparation for the market. In the washroom considerable quantities of the outer leaves are removed, and these should not be allowed to accumulate. In some cases on celery farms water from springs or that from flowing wells is kept running through the wash tanks continuously, the water passing through the

rinsing tank first, then into the wash tank, which is placed a few inches lower than the rinsing tank. This gives ideal conditions, but the tanks should be provided with a large opening in the bottom, connected with a drain, and should be thoroughly scrubbed out at least once a day or at the end of each washing period.

COST OF GROWING AND RETURNS RECEIVED.

Cost accounting on the part of celery growers has been so neglected and conditions vary so greatly one year with another that it is difficult

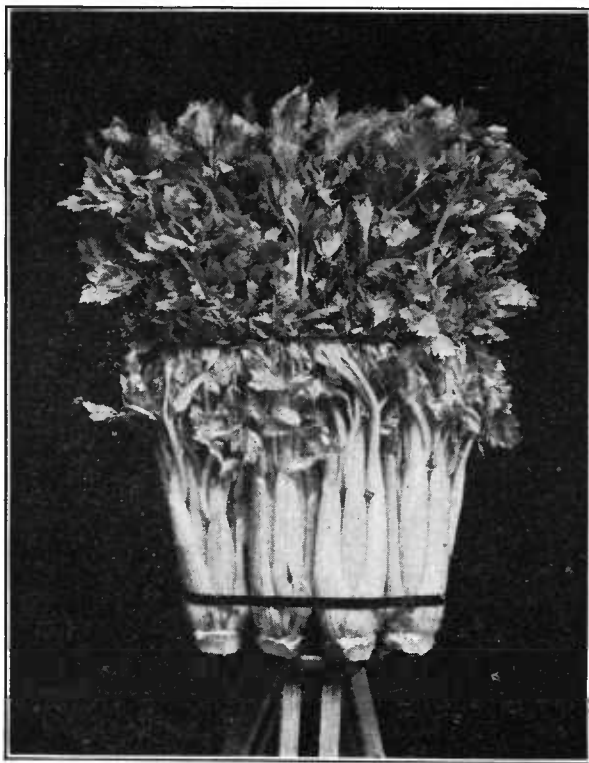


FIG. 19.—Celery trimmed, washed, and bunched ready for the market.

to give figures that will be of real value. The principal items of expense connected with the growing of a celery crop are: Interest on investment in land and equipment used in the work; plowing and fitting the land, including drainage and irrigation expenses; fertilizers and their application; seeds and plants, including the care of plants during the period of early growth until they are ready to set in the field; setting, cultivating, and spraying the plants; the proportionate cost of the boards or paper used in blanching; the labor of blanching, harvesting, packing, and hauling to market, to the car, or to the storage house; selling costs, including cost of crates and membership in the association or selling organization; and where the celery is washed

on the farm and sold to a special trade the costs connected with this will have to be taken into consideration. Those who are familiar with the work of growing celery realize that it is an expensive crop to grow, but, on the other hand, where a yield of 400 to 500 crates to the acre is obtained the returns are generally in proportion to the cost of growing, and a very nice profit is realized. It is safe to assume that the celery grower who is not making a profit of \$200 to \$300 an acre is falling short of his goal. The only way, however, to determine just what is being made from the work is to keep a careful cost account and balance this against the returns.

VARIETIES OF CELERY.

Golden Self-Blanching, either the true type or some of its strains, has been the standard commercial variety for a great many years, but unfortunately this variety is very susceptible to blight. Recently there have been developed several varieties and types having the easy blanching characteristics of Golden Self-Blanching, but more hardy and resistant to disease. In some sections, especially in New England, the old Boston Market and Giant Pascal still find an important place, being grown for particular markets.

Recently two or three varieties of the Golden Heart type have found favor with those who are growing celery for near-by or local markets. The essential requirements, however, of a variety of celery for either home use or the market are vigor of growth, resistance to disease, ease of blanching, good storage qualities, good appearance, good flavor, and crispness when served on the table. These characters seem to be pretty fully embodied in the variety known as Easy Blanching, which is now being grown quite extensively throughout the eastern United States. There is need, however, for some careful plant-breeding work with a view to developing strains of celery that will more nearly meet present requirements.

GROWING CELERY SEED.

Celery seed is produced in France and Italy by starting the plants late in the season and allowing them to grow rather thickly in rows about 3 feet apart. During the fall they are rogued, all off-type plants being removed. The remaining plants are covered lightly with straw or given some protection during the winter, and during the following spring they throw up seed stalks, blossom, and produce seed. A number of celery growers in northern New Jersey and in the Boston district grow their own supply of celery seed, as a rule an old coldframe being used for the purpose. Following the planting of the field crop of celery, plants are selected from the plant bed and are set about 12 inches apart in each direction in the coldframe. By

selecting the plants carefully very little roguing is necessary, but any plants that are "off type" are pulled out during the autumn. A slight mulch of straw or a mixture of straw and manure is placed around the plants in the autumn and a covering of old sash put on during the coldest part of the winter. Sometimes through the very coldest periods the sash are covered with straw or with old hotbed mats. In the spring the covering and the mulch are removed and the plants left to produce their seed. Figure 20 shows a bed of celery grown for seed, the plants being in bloom and part of the seed formed.

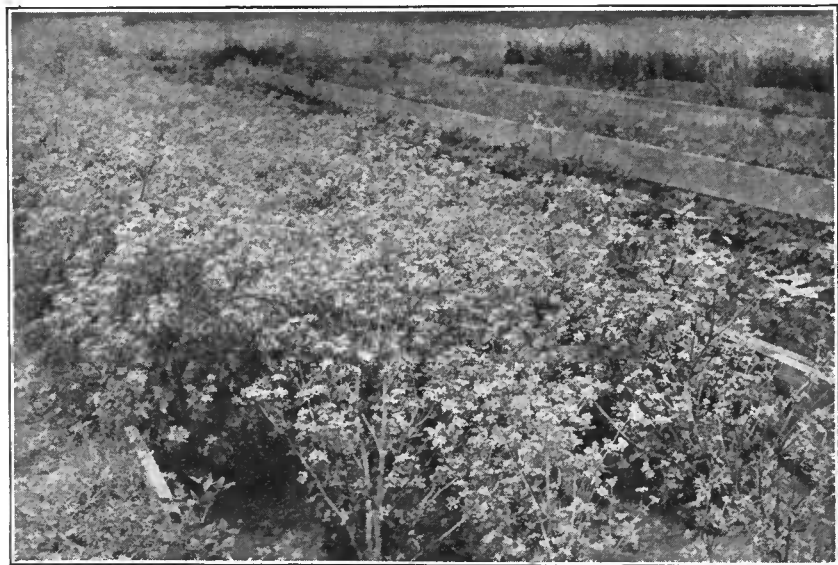


FIG. 20.—Celery plants grown for seed production.

The seed is not gathered until just before it begins to shatter; in other words, it should be reasonably ripe on the plant before being removed. In gathering the seed the stems are cut off 8 or 10 inches below the seed heads, tied in bunches, and hung in a shed or other well-ventilated place to dry. The seed should not be dried in the sun or left exposed, but kept under shelter. It is an easy matter to remove the seed by beating the heads on a sheet or canvas and later cleaning the seed by letting it fall on a sheet when the wind is blowing sufficiently strong to carry away the chaff.

A comparatively small number of celery plants are required to produce the seed used by the average celery grower, and those who are in a position to do so should give some attention to the matter of seed production and improvement.